USER'S MANUAL
for the

LTCA-10™
LTCA-40™

LOAD TAP CHANGER ANALYZER





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SAFETY SUMMARY

NOTICE

This manual applies to both the LTCA-10 and LTCA-40. The operating procedures are virtually the same for both models, and any differences are clearly described within the step-by-step procedures.

FOLLOW EXACT OPERATING PROCEDURES

Any deviation from the procedures described in this User's Manual may create one or more safety hazards, may damage the LTCA-10/40, damage the test transformer, or cause errors in the test results. Vanguard Instruments Company, Inc. assumes no liability for unsafe or improper use of the LTCA-10/40.

All safety precautions provided in this manual must be observed during all phases of testing including test preparation, test lead connection, actual testing, and test lead disconnection.

SAFETY WARNING AND CAUTIONS

The LTCA-10/40 shall be used only **by trained operators**. All transformers under test shall be off-line and **fully isolated**.

DO NOT MODIFY TEST EQUIPMENT

To avoid the risk of introducing additional or unknown hazards, do not install substitute parts or perform any unauthorized modification to any LTCA-10/40 test unit. To ensure that all designed safety features are maintained, it is highly recommended that repairs be performed only by Vanguard Instruments Company factory personnel or by an authorized repair service. Unauthorized modifications can cause safety hazards and will void the manufacturer's warranty.

WARNING

Do not remove test leads during a test. Failure to heed this warning can result in electrical shock to personnel and damage to the equipment.

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CONVENTIONS USED IN THIS DOCUMENT

This document uses the following conventions:

- A key or switch on the LTCA-10/40 is indicated as **[KEY]**
- Menu options are referenced as (*MENU OPTION*)
- Screen and menu names are referenced as "SCREEN/MENU NAME"
- LTCA-10/40 LCD screen output is shown as:

```
1. OPTION 1
2. OPTION 2
3. OPTION 3
```

- Warning messages are indicated as:

WARNING	Warning message

- Important notes are indicated as:

NOTE	Note details

1.0 INTRODUCTION

1.1 General Description

The Vanguard LTCA-10 and LTCA-40 are microprocessor-controlled winding resistance meters. These devices are designed to accurately measure large transformer winding resistance, motor winding resistance, or the resistance of large inductive devices. This manual addresses the LTCA-10 and LTCA-40 as one device. Any differences between the LTCA-10 and LTCA-40 are addressed separately.

The LTCA-10 uses a 60Vdc/10 Amperes Direct Current (DC) power supply while the LTCA-40 uses a 60VDC/40 Amperes DC power supply. Both devices are capable of reading winding resistances ranging from 1 micro-ohm to 500 ohms. Three voltage sensing channels allow the LTCA-10/40 to read three resistance values in the same test. To ensure operator safety, the LTCA-10/40 automatically discharges the stored energy in the transformer at the end of each test.

The LTCA-10/40 has one resistance reading channel (V1) dedicated for dynamic resistance testing. The dynamic resistance test feature can be used to monitor the transformer LTC or Voltage Regulator contact resistance while changing tap positions. A resistance plot shows the transformer LTC contact and winding resistance and can be used to detect LTC/Voltage Regulator contact problems.

The transformer LTC or Voltage Regulator AC motor current can also be monitored by the LTCA-10/40 using an AC clamp on the current sensor. This feature can be used to monitor the LTC motor "On-Time" at each tap change operation.

The LTCA-10/40 is rugged, portable, and easy to use, requiring little training for first-time users. A 16-key membrane keypad is used to control the unit. The LTCA-10/40 features a back-lit LCD screen (64 x 128 dot graphic) that is viewable in bright daylight as well as low-light conditions. A built-in thermal printer can print results on 4.5-inch wide thermal paper.

The LTCA-10/40 can store 128 static test records (48 tests per record) and 11 dynamic resistance test records in Flash EEPROM. Test records can be recalled locally or transferred to a PC via the available interfaces (RS-232C port, USB port, USB Flash drive port). A built-in USB Flash drive interface provides a convenient method for transferring test records to or from a USB Flash drive. Test records can also be transferred directly to a PC via the RS-232C or USB interface ports. If using a USB Flash drive, test records stored in the LTCA-10/40's internal memory can be transferred to the drive, and then the supplied PC software can be used to view the test records stored on the drive. Up to 999 test records can be stored on a USB Flash drive.

1.2 Functional Description

The LTCA-10/40's operation is based on the electrical relationship described by Ohm's law: R=V/I, where I is a known current and V is the DC voltage measured across the unknown resistance. The value of the unknown resistance is calculated by dividing the measured voltage by the current which is calculated by the microprocessor. Calculated resistance readings are then displayed on the unit's back-lit LCD screen.

A special current source allows the LTCA-10 to output 1, 5 and 10 Amperes of test current. The LTCA-40 can output 1, 5, 10 or 40 Amperes of test current. For added safety, the current source

circuit is thermally protected. Also, a built-in discharge circuit automatically discharges the stored energy in the transformer at the end of each test.

1.3 Furnished Accessories

The LTCA-10/40 is furnished with eight 50-foot test cables with "quick disconnect" type test plugs on the unit end and battery-type clamps at the test load end. One power cord, one ground cable, one current sense cable, one LTC operation cable and a cable-carrying bag is also included.

2.0 TECHNICAL SPECIFICATIONS

2.1 LTCA-10 Technical Specifications



Table 1.0 LTCA-10 Specifications

TYPE	Load tap changer analyzer
PHYSICAL SPECIFICATIONS	21"W x 9" H x 17"D (53 cm x 24 cm x 43 cm); Weight: 33 lbs (15.4 kg)
OPERATING VOLTAGE	100 – 240 Vac, 50/60 Hz
RESISTANCE READING RANGE	1 micro-ohm – 500 ohms
ACCURACY	1 – 19,999 micro-ohms: ±0.5% reading, ±1 count; 20 – 999 milli-ohms: ±1% reading, ±1 count; 1 – 500 ohms: ±1.5% reading, ±1 count
RESISTANCE CHANNELS	Three static resistance reading channels, One dynamic resistance channel
TEST VOLTAGE	60 Vdc max
TEST CURRENTS	1 ampere, 5 amperes, 10 amperes
AC CURRENT PROBE	Clamp-on current sensor, 1 – 20 Amperes, AEMC model MN106
DISPLAY	Back-lit LCD Screen (64 x 128 dot graphic); viewable in bright sunlight and low-light levels
PRINTER	4.5-inch wide thermal printer
EXTERNAL DATA STORAGE	One USB Flash drive interface port; stores up to 999 test records on a USB Flash drive (not included)
COMPUTER INTERFACES	One RS-232C port, One USB port
INTERNAL TEST RECORD STORAGE	Stores up to 128 static resistance test records (48 tests per record) and 11 dynamic resistance test records
LOAD TAP CHANGER CONTACT	240 Vac, 1A
SAFETY	Designed to meet UL 61010A-1 and CAN/CSA C22.2 No. 1010.1-92 standards
ENVIRONMENT	Operating: -10˚C to 50˚ C (15˚F to +122˚ F); Storage: -30˚ C to 70˚ C (-22˚F to +158˚ F)
CABLES	One 50-foot current cable set, Three 50-foot resistance cable sets, One ground cable, One USB cable, One RS-232C cable, One current sense cable, One LTC control cable, power cord, cable bag
OPTIONS	Transportation Case
WARRANTY	One year on parts and labor

NOTE

The above specifications are valid at nominal operating voltage and at a temperature of 25°C (77°F). Specifications may change without prior notice.

2.2 LTCA-40 Technical Specifications



Table 2.0 LTCA-40 Specifications

TYPE	Load tap changer analyzer
PHYSICAL SPECIFICATIONS	25"W x 8.5"H x 20"D (63.5 cm x 21.6 cm x 50 cm); Weight: 46 lbs (20 kg)
OPERATING VOLTAGE	100 – 240 Vac, 50/60 Hz
RESISTANCE READING RANGE	1 micro-ohm – 500 ohms
ACCURACY	1 – 19,999 micro-ohms: ±0.5% reading, ±1 count; 20 – 999 milli-ohms: ±1% reading, ±1 count; 1 – 500 ohms: ±1.5% reading, ±1 count
RESISTANCE CHANNELS	Three static resistance reading channels, One dynamic resistance channel
TEST VOLTAGE	60 Vdc max
TEST CURRENTS	1 ampere, 5 amperes, 10 amperes, 40 amperes
AC CURRENT PROBE	Clamp-on current sensor, 1 – 20 Amperes, AEMC model MN106
DISPLAY	Back-lit LCD Screen (64 x 128 dot graphic); viewable in bright sunlight and low-light levels
PRINTER	4.5-inch wide thermal printer
EXTERNAL DATA STORAGE	One USB Flash drive interface port; stores up to 999 test records on a USB Flash drive (not included)
COMPUTER INTERFACES	One RS-232C port, One USB port
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CABLES	One 50-foot current cable set, Three 50-foot resistance cable sets, One ground cable, One USB cable, One RS-232C cable, One current sense cable, One LTC control cable, power cord, cable bag
OPTIONS	Transportation Case
WARRANTY	One year on parts and labor

NOTE

The above specifications are valid at nominal operating voltage and at a temperature of 25°C (77°F). Specifications may change without prior notice.

3.0 CONTROLS AND INDICATORS

3.1 LTCA-10 Controls and Indicators

The LTCA-10's controls and indicators are shown in Figure 1.0 below. A leader line with an index number points to each control and indicator, which is cross-referenced to a functional description in Table 3.0. The table describes the function of each item on the control-panel. The purpose of the controls and indicators may seem obvious, but users should become familiar with them before using the LTCA-10/40. Accidental misuse of the controls will usually cause no serious harm. Users should also be familiar with the safety summary found on the front page of this User's Manual.

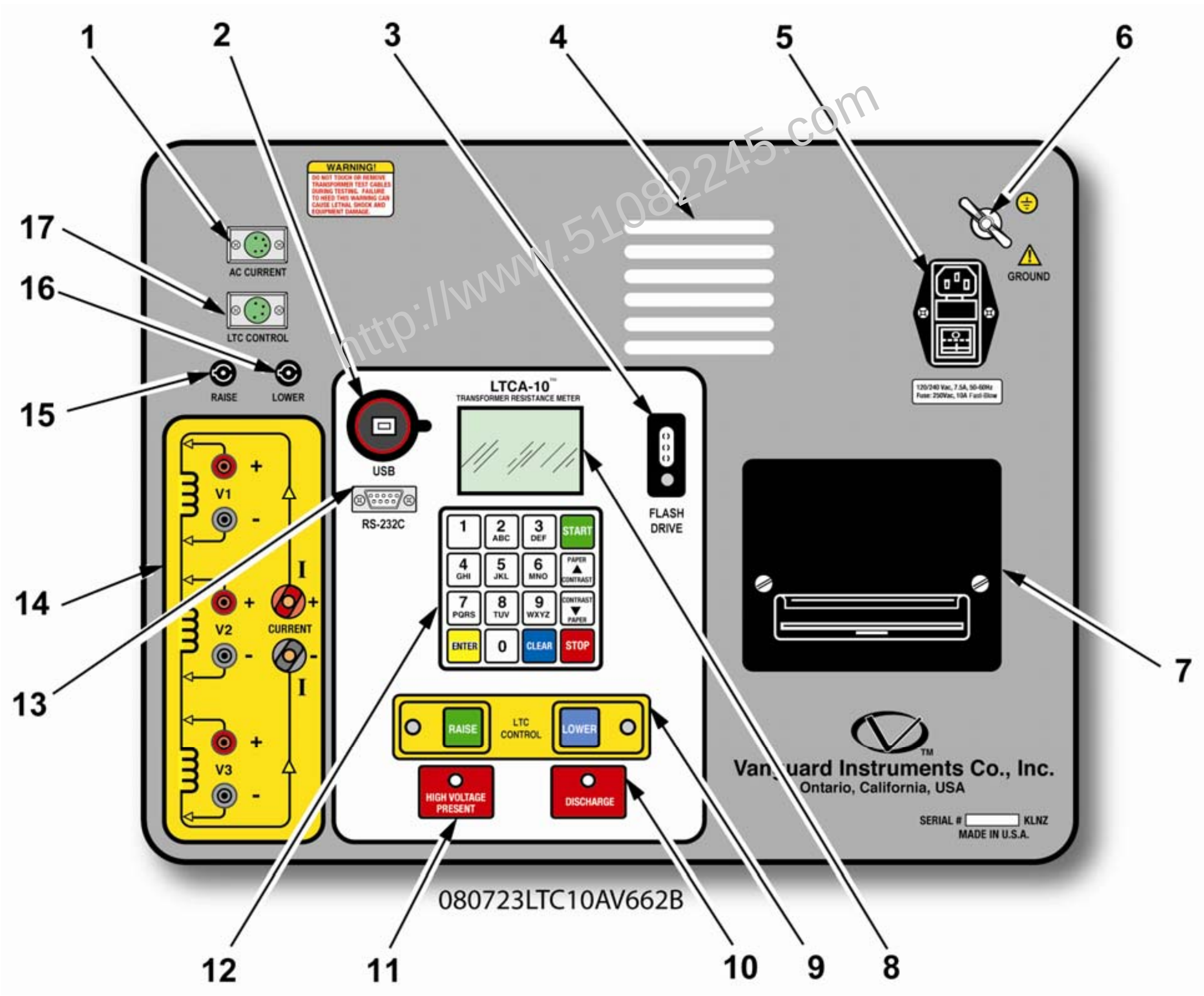


Figure 1.0 LTCA-10 Controls and Indicators

Table 3.0 Functional Descriptions of LTCA-10 Controls and Indicators

<table>
<tr><th>Item Number</th><th>Panel Markings</th><th>Functional Description</th></tr>
<tr><td>1</td><td>AC Current</td><td>Clamp-on AC current probe connector</td></tr>
<tr><td>2</td><td>USB</td><td>USB Interface Port</td></tr>
<tr><td>3</td><td>Flash Drive</td><td>USB Flash Drive Interface Port</td></tr>
<tr><td>4</td><td>None</td><td>Air Vents</td></tr>
<tr><td>5</td><td>120-240 7.5A, 50-60 Hz
Fuse: 250Vac, 1A Fast-Blow</td><td>Input power connector with third-wire safety ground, ON/OFF rocker toggle switch with built-in fuse protection</td></tr>
<tr><td>6</td><td>GROUND</td><td>5/16-18 threaded stud, with hand-turned wing nut, safety ground. This must be connected to station ground before connecting LCTA-10 test leads to the transformer</td></tr>
<tr><td>7</td><td>None</td><td>Built in 4.5-inch wide thermal printer.
NOTE: For best printing results, it is recommended that only VIC thermal paper be used</td></tr>
<tr><td>8</td><td>None</td><td>Liquid-Crystal Display, 64 x 128 dot graphic display. Back-lit and viewable in bright sunlight and low-light conditions. Displays menus, user selections, status readouts and test results</td></tr>
<tr><td>9</td><td>LTC Control</td><td>Load Tap Changer Control. Allows the user to change the Load Tap Changer position using the RAISE and LOWER buttons</td></tr>
<tr><td>10</td><td>DISCHARGE</td><td>Red LED indicator light. When lit, this indicator warns the operator that the LTCA-10 is discharging the stored energy in the transformer.
Do not disconnect test leads when this light is on. Failure to heed this warning can result in shock to personnel</td></tr>
<tr><td>11</td><td>HIGH VOLTAGE PRESENT</td><td>Red LED indicator light. Lights to warn operator that there is a possibility that voltage exists across test leads.
Do not disconnect test leads when this light is on. Failure to heed this warning can result in shock to personnel</td></tr>
<tr><td>12</td><td>None</td><td>Membrane keypad, 10 alpha-numeric keys and 6 function keys (START, STOP, CLEAR, ENTER, and CONTRAST/PAPER positioning UP and DOWN)</td></tr>
<tr><td>13</td><td>RS-232C</td><td>9-pin RS-232C interface port; female DB type. Data rate is set to 19,200 baud, 1 start bit, 2 stop bits, 8 data bits and no parity bit
<table>
<tr><th>Pin</th><th>Signal</th></tr>
<tr><td>2</td><td>RX</td></tr>
<tr><td>3</td><td>TX</td></tr>
<tr><td>5</td><td>Signal Ground</td></tr>
</table></td></tr>
<tr><td>14</td><td>V1, V2, V3, CURRENT (I+, I-)</td><td>Voltage sensing input channels 1, 2, and 3. Female test connector jacks for connecting test current output test leads</td></tr>
<tr><td>15</td><td>RAISE</td><td>Fuse for the LTC Control Raise leads</td></tr>
<tr><td>16</td><td>LOWER</td><td>Fuse for the LTC Control Lower leads</td></tr>
<tr><td>17</td><td>LTC CONTROL</td><td>Load Tap Changer controller connector</td></tr>
</table>

3.2 LTCA-40 Controls and Indicators

The LTCA-40's controls and indicators are shown in Figure 2.0 below. A leader line with an index number points to each control and indicator, which is cross-referenced to a functional description in Table 4.0. The table describes the function of each item on the control-panel. The purpose of the controls and indicators may seem obvious, but users should become familiar with them before using the LTCA-10/40. Accidental misuse of the controls will usually cause no serious harm. Users should also be familiar with the safety summary found on the front page of this User's Manual.

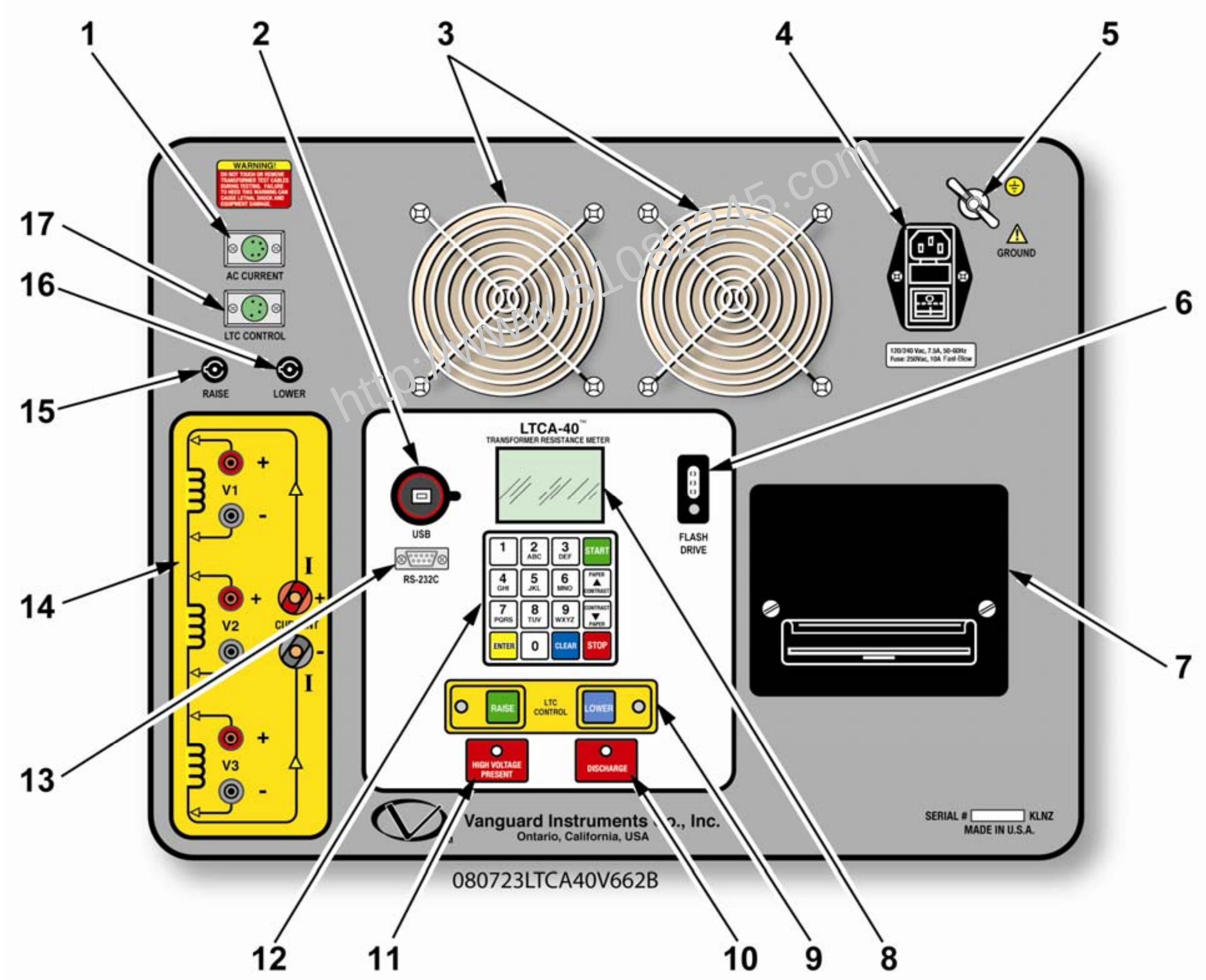


Figure 2.0 LTCA-40 Controls and Indicators

Table 4.0 Functional Descriptions of LTCA-40 Controls and Indicators

Item Number	Panel Markings	Functional Description
1	AC Current	Clamp-on AC current probe connector
2	USB	USB Interface port
3	None	The air intake cooling fans maintain the internal temperature. There are output air fans on the sides of the case
4	120-240 7.5A, 50-60 Hz Fuse: 250Vac, 1A Fast-Blow	Input power connector with third-wire safety ground, ON/OFF rocker toggle switch with built-in fuse protection
5	GROUND	5/16-18 threaded stud, with hand-turned wing nut, safety ground. This must be connected to station ground before connecting LCTA-40 test leads to the transformer
6	Flash Drive	USB Flash Drive Interface Port
7	None	Built in 4.5-inch wide thermal printer NOTE: For best printing results, it is recommended that only VIC thermal paper be used
8	None	Liquid-Crystal Display, 64 x 128 dot graphic display. Back-lit and viewable in bright sunlight and low-light conditions. Displays menus, user selections, status readouts and test results
9	LTC Control	Load Tap Changer Control. Allows the user to change the Load Tap Changer position using the RAISE and LOWER buttons
10	DISCHARGE	Red LED indicator light. When lit, this indicator warns the operator that the LTCA-40 is discharging the stored energy in the transformer. ***Do not disconnect test leads when this light is on. Failure to heed this warning can result in shock to personnel***
11	HIGH VOLTAGE PRESENT	Red LED indicator light. Lights to warn operator that there is a possibility that voltage exists across test leads. ***Do not disconnect test leads when this light is on. Failure to heed this warning can result in shock to personnel***
12	None	Membrane keypad, 10 alpha-numeric keys and 6 function keys (START, STOP, CLEAR, ENTER, and CONTRAST/PAPER positioning UP and DOWN)
13	RS-232C	9-pin RS-232C interface port; female DB type. Data rate is set to 19,200 baud, 1 start bit, 2 stop bits, 8 data bits and no parity bit **Pin** / **Signal**: 2 – RX; 3 – TX; 5 – Signal Ground
14	V1, V2, V3, CURRENT (I+, I-)	Voltage sensing input channels 1, 2, & 3. Female test connector jacks for connecting test current output test leads
15	RAISE	Fuse for LTC Control Raise leads
16	LOWER	Fuse for LTC Control Lower leads
17	LTC CONTROL	Load Tap Changer controller connector

Pin	Signal
2	RX
3	TX
5	Signal Ground

4.0 PRE-TEST SETUP

4.1 Operating Voltages

The LTCA-10/40's operating voltages are 100-240 Vac and 50/60 Hz.

4.2 LTCA-10/40 LCD Contrast Control

To increase the LCD screen contrast, press and hold the **[PAPER ∧ Contrast]** key for two seconds.

To decrease the LCD screen contrast, press and hold the **[PAPER ∨ Contrast]** key for two seconds.

4.3 LTCA-10/40 Printer Paper Control

To advance the LTCA-10/40 printer paper, press and release the **[PAPER ∧ Contrast]** key.

To retract the LTCA-10/40 printer paper, press and release the **[PAPER ∨ Contrast]** key.

4.4 LTCA-10/40 Printer Paper

The LTCA-10/40's built-in thermal printer uses 4.5-inch wide thermal paper for printing test results. To maintain the highest print quality and to avoid paper jams, the use of thermal paper supplied by Vanguard Instruments Company is highly recommended. Additional paper can be ordered from the following sources:

Vanguard Instruments Co, Inc.
1520 S. Hellman Avenue
Ontario, CA 91761
Tel: 909-923-9390
Fax: 909-923-9391
Part Number: VIC TP-4 paper

BG Instrument Co.
13607 E. Trent Avenue
Spokane, WA 99216
Tel: 509-893-9881
Fax: 509-893-9803
Part Number: VIC TP-4 paper

5.0 OPERATING PROCEDURES

The LTCA-10/40 is simple to operate and only requires the selection of choices from display menus and responding to displayed prompts. However, first-time operators should review the following operating procedures to become familiar with all LTCA-10/40 operations and the logical branching for various test options. More experienced operators may use these procedures as a handy help and reference guide.

5.1 Typical Connections to a Load Tap Changer (LTC)

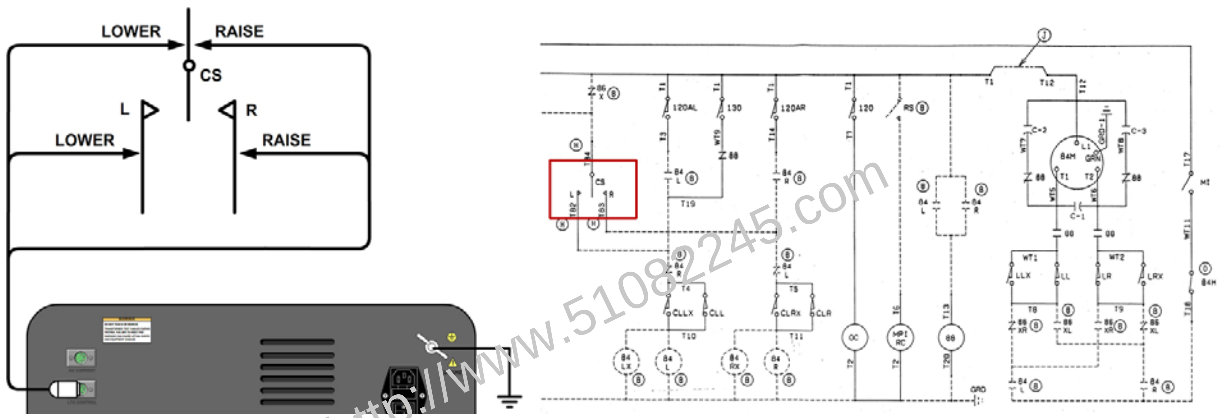


Figure 3.0 Typical Connections to a Load Tap Changer (LTC)

5.2 LTCA-10 Cable Connections

WARNING

Do not touch or disconnect any test lead that is connected to a transformer terminal while high current is being conducted **during a test**. Failure to heed this warning can result in **electrical shock** to personnel and/or **damage to the equipment**.

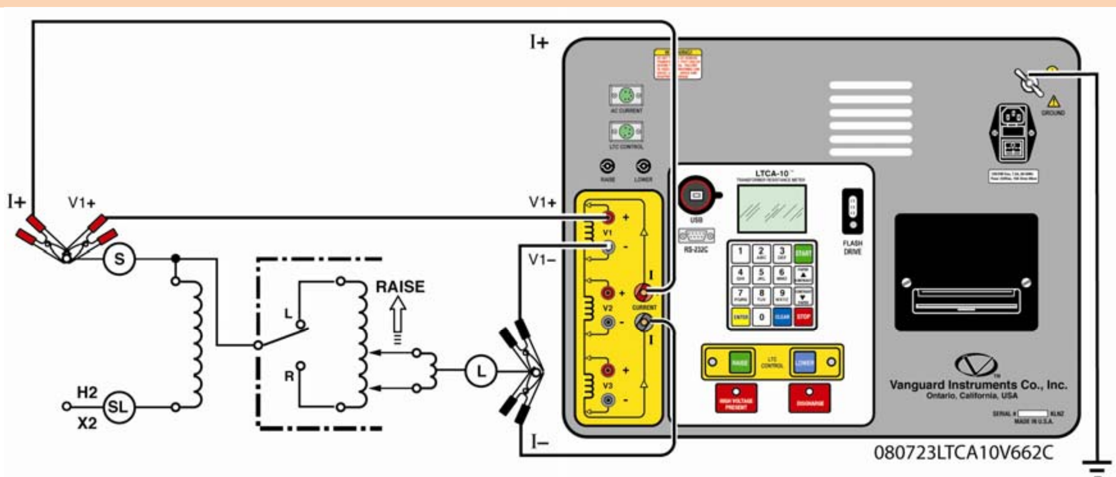


Figure 4.0 Typical LTCA-10 Connection Diagram (Dynamic Resistance Test)

WARNING

After discharge, always **disconnect test clips slowly** from transformer bushings to prevent an accidental flash-over.

5.3 LTCA-40 Cable Connections

Typical connection diagrams of the LTCA-40 are shown in Figure 4.0, 5.0, and 6.0.

WARNING

Do not touch or disconnect any test lead that is connected to a transformer terminal while high current is being conducted **during a test**. Failure to heed this warning can result in **electrical shock** to personnel and/or **damage to the equipment**.

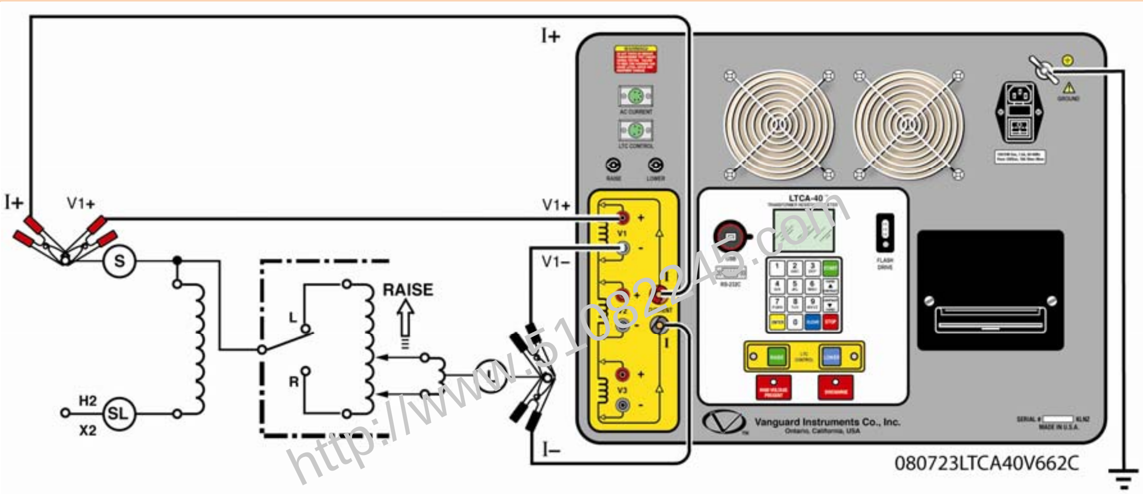


Figure 5.0 Typical LTCA-40 Connection Diagram (Dynamic Resistance Test)

WARNING

After discharge, always **disconnect test clips slowly** from transformer bushings to prevent any accidental flash-over.

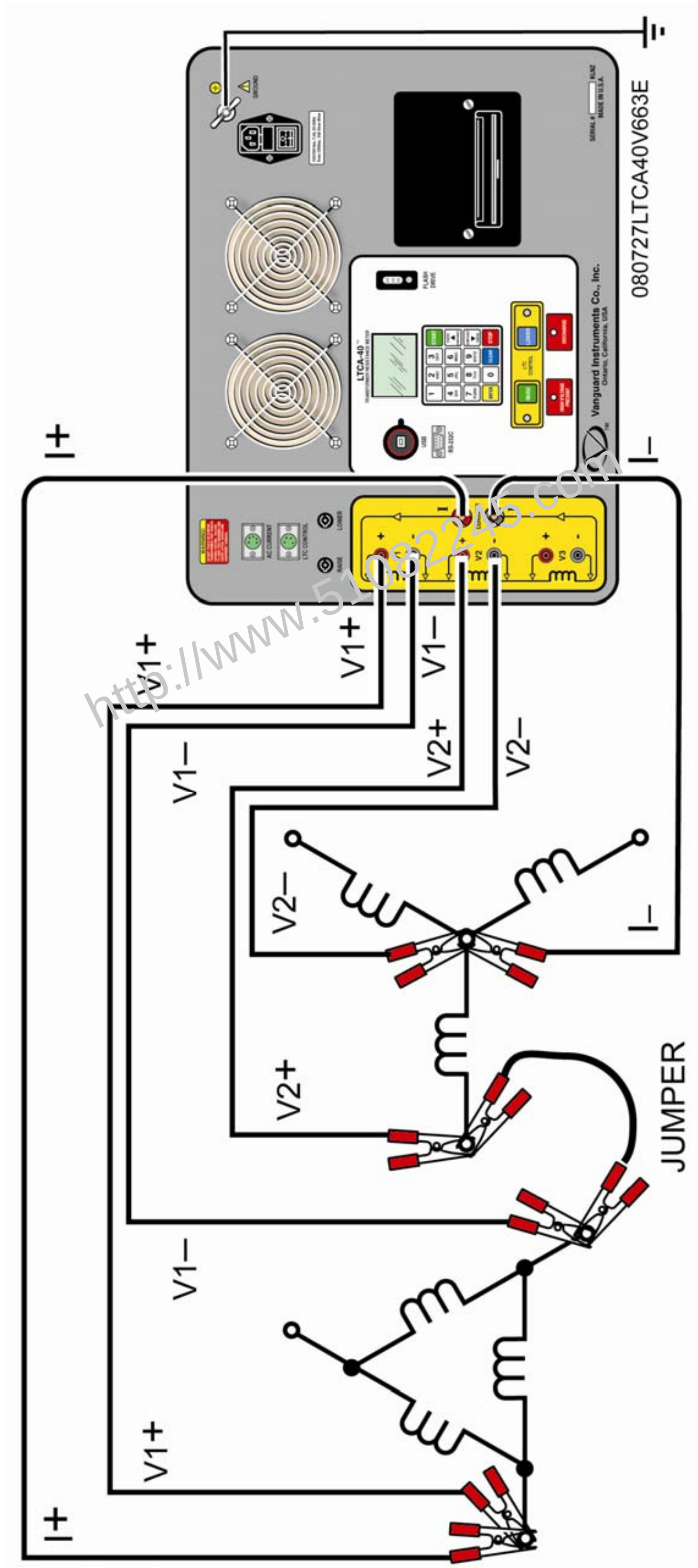


Figure 6.0 Typical LTCA-40 Connection Diagram (2 Windings)

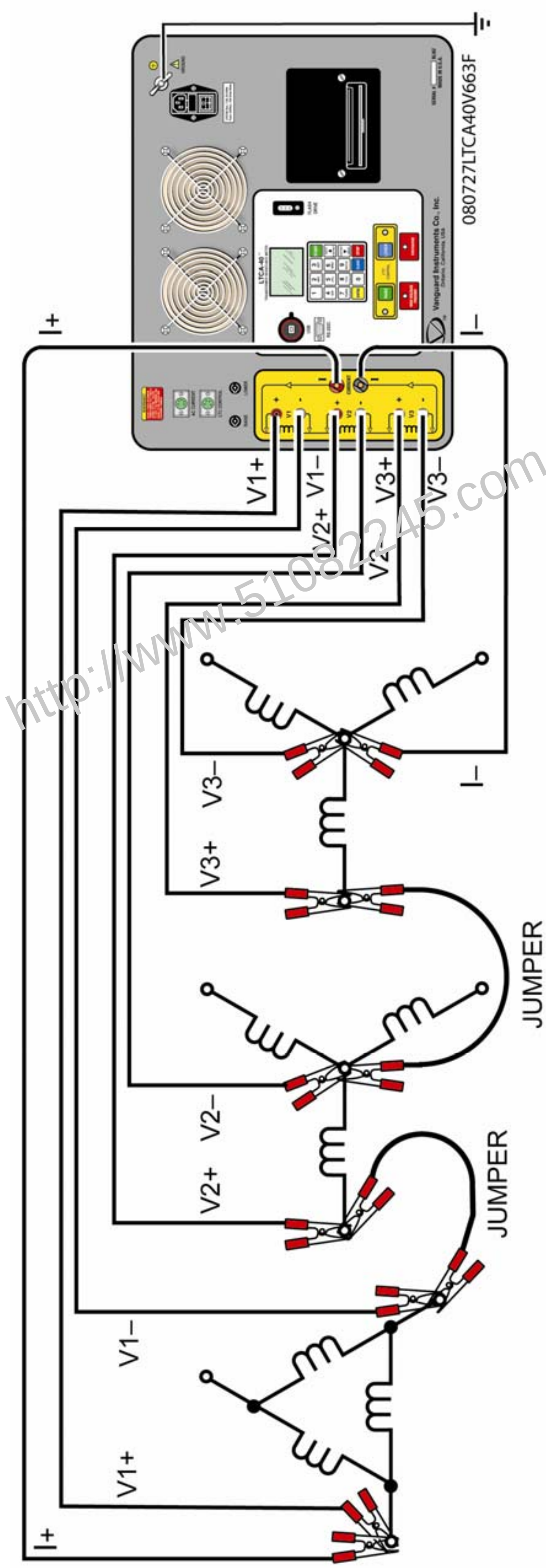


Figure 7.0 Typical LTCA-40 Connection Diagram (3 Windings)

5.4 General Procedures

a. Ground the LTCA-10/40 to substation ground (Item 6 in Figure 1.0, Item 5 in figure 2.0).

> **WARNING** Always connect the LTCA-10/40 to the substation ground before connecting test leads to any transformer bushing. Failure to follow this procedure may damage the LTCA-10/40.

b. Plug the LTCA-10/40 power cable into a power outlet.

c. Insert current-cable plugs and voltage-sensing cable plugs into their respective control panel jacks.

d. Attach test-cable clamps to the transformer terminals for the winding that is to be measured.

e. Turn on the LTCA-10/40 power by pressing **[I]** on the rocker switch.

f. Once the power is turned on, the unit will perform self-calibration and display a few start-up messages. Once the short start-up sequence is completed, the "START-UP" menu will be displayed (date and time will obviously be different):

```
1. TEST XFMR      03/04/09
2. SETUP          09:28:03
3. USER DIAG
```

5.5 Performing a Resistance Test

a. Start from the "START-UP" menu:

```
1. TEST XFMR      03/04/09
2. SETUP          09:28:03
3. USER DIAG
```

Press the **[1]** key (*TEST XFMR*) to start a test.

b. The following menu will be displayed:

```
1. RESISTANCE TEST
2. SPECIAL RESISTANCE TEST
3. DYNAMIC LTC TEST
```

Press the **[1]** key (*RESISTANCE TEST*) to start a resistance test.

c. The following menu will be displayed:

```
1. V1, V2, V3 RES TEST
2. V1, V2     RES TEST
3. V1 ONLY    RES TEST
```


Select the number of channels that will be used to measure resistance by pressing the corresponding numeric key (**[1]**, **[2]**, or **[3]**).

d. The "SELECT TEST CURRENT" menu will be displayed:

```
SELECT TEST CURRENT:
1. 1 AMP
2. 5 AMPS
3. 10 AMPS
```

LTCA-10

```
SELECT TEST CURRENT:
1. 1 AMP
2. 5 AMPS
3. 10 AMPS
4. 40 AMPS
```

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Select the test current by pressing the **[1]**, **[2]**, **[3]** , or **[4]** (LTCA-40 only) key.

e. The "CONVERT READINGS TO STANDARD TEMP?" menu will be displayed as shown below:

```
   CONVERT READINGS TO
     STANDARD TEMP?
1. YES
2. NO
```

1. *YES*
   If you wish to convert readings to standard temperature, press the **[1]** key (*YES*). The "WINDING MATERIAL" menu will be displayed:

```
     WINDING MATERIAL
1. COPPER, Tk=234.5
2. ALUMINUM, Tk=225.0
3. MANUALLY ENTER Tk
```

a. Press the **[1]** key to select copper as the winding material. **Continue to step f.**

b. Press the **[2]** key to select aluminum as the winding material. **Continue to step f.**

c. Press the **[3]** key to manually enter the Tk value. The following screen will be displayed:

```
        Tk:
      230.0°C

↑↓ to adjust Tk
"ENTER" to accept
```

You can increase the Tk value by 0.5°C increments by pressing the **[PAPER ∧ Contrast]** key. You can decrease the Tk value by 0.5°C increments by pressing the **[PAPER ∨ Contrast]** key. Press the **[ENTER]** key to confirm your temperature selection. **Continue to step f.**

2. *NO*
If you do NOT wish to convert readings to standard temperature, press the **[2]** key (*NO*) and **continue to step h**.

f. After the Tk value has been selected, the "D.U.T. TEMP" screen will be displayed:

```
    D.U.T. TEMP
  25.0°C    77.0°F

↑↓ to adjust temp
"ENTER" to accept
```

Use the **[PAPER ∧ Contrast]** and **[PAPER ∨ Contrast]** keys to adjust the D.U.T. temperature. Press the **[ENTER]** key to confirm the temperature selection.

> D.U.T is short for Device Under Test
>
> **NOTE**

g. The "REFERENCE TEMP" screen will be displayed:

```
  REFERENCE TEMP:
  85.0°C   185.0°F

↑↓ to adjust temp
"ENTER" to accept
```

Use the **[PAPER ∧ Contrast]** and **[PAPER ∨ Contrast]** keys to adjust the Reference Temperature. Press the **[ENTER]** key to confirm the temperature selection.

NOTE The LTCA-10/40 will calculate the equivalent resistance value at this new temperature.

h. The following "WARNING" screen will be displayed:

```
*********WARNING*********
  DANGEROUS FLASH-OVER
  WILL OCCUR IF CABLES
   ARE DISCONNECTED!
*************************
```

This warning reminds the operator that the next sequence of test steps will run current through the test load.

Press the **[ENTER]** key to proceed to the next step.

i. One of the following menus will be displayed (with the relevant test current value) depending on how many channels were selected in step c.


```
    -V1 TEST ONLY-
      1 AMP TEST

  "START" TO RUN TEST
          OR
    "STOP" TO ABORT
```

V1 Test Only

```
    -V1 & V2 TEST-
      1 AMP TEST

  "START" TO RUN TEST
          OR
    "STOP" TO ABORT
```

V1 & V2 Test

```
  -V1, V2, & V3 TEST-
      1 AMP TEST

  "START" TO RUN TEST
          OR
    "STOP" TO ABORT
```

V1, V2, & V3 Test

If you have made any errors or would like to abort the test, press the **[STOP]** key, and you will be returned to the "START-UP" menu.

Press the **[START]** key to run the test. The following screen will be displayed momentarily:

```
     CALIBRATING
    PLEASE WAIT…
```

After the LTCA-10/40 finishes its internal calibration, the "XFMR CHARGING" screen will be displayed:

```
    XFMR CHARGING
   PLEASE WAIT...

  * XFMR ENERGIZED! *
```

This is only an informational screen to remind the operator that a test is in progress. The display duration of this message depends on the size of the winding's inductance and the test current selected.

> **NOTE** You can bypass this delay and observe the resistance value immediately. See section 6.1 for instructions on how to select this option.

j. The LTCA-10/40 determines when the resistance reading is stable and displays the resistance values on the LCD screen as follows:

```
    TEST IN PROGRESS
  I  = 1.09 AMPS
  R1 = 7.272 mΩ
  R2 = 358µΩ
   * XFMR ENERGIZED! *
```


The LTCA-10/40 will continue the test and update the resistance values on the LCD screen. While the test is in progress, the **[ENTER]** key can be pressed to save the current reading on the LCD to the LTCA-10/40's internal working memory.

This feature is very convenient for storing multiple readings during a test. A typical example of this application is an LTC or Voltage Regulator contact resistance test where multiple readings are required. For example, the user can start the test at one tap position, and when the reading is stable, press the **[ENTER]** key to save the reading. Then, the user can change the tap position and save the stable reading at the new tap position by pressing the **[ENTER]** key. This process can be repeated as needed for a maximum of 48 times per test record.

If the **[ENTER]** key is pressed, the data is saved and the SAVING TEST message will be displayed on the LCD as shown below:

```
    TEST IN PROGRESS
 ====> SAVING TEST <====
  I  = 1.09 AMPS
  R1 = 7.272 mΩ
  R2 = 358µΩ
   * XFMR ENERGIZED! *
```

Once the data is saved, the TEST SAVED message will be displayed:

```
    TEST IN PROGRESS
 ====> TEST SAVED! <====
  I  = 1.09 AMPS
  R1 = 7.272 mΩ
  R2 = 358µΩ
   * XFMR ENERGIZED! *
```

k. Press the **[STOP]** key to stop running the test. Press the **[STOP]** key a second time to continue to the next step.

l. The "PRINT TEST RESULTS?" menu will be displayed:

```
PRINT TEST RESULTS?
1. YES
2. NO
```

1. *YES*
   Press the **[1]** key (*YES*) to print the test results on the built-in thermal printer. The last test results displayed on the LCD screen will be printed. Typical LTCA-10/40 test reports are shown in Figure 7.0, Figure 8.0, and Figure 9.0. **Continue to step m.**

2. *NO*
   Press the **[2]** key (*NO*) to bypass the printing of the test results. **Continue to step m.**

m. The "KEEP THIS READING?" menu will be displayed:


```
KEEP THIS READING?
1. YES
2. NO
```

1. *YES*
   If you wish to save the reading, press the **[1]** key (*YES*). One of the following screens will be displayed:

   The following screen will be displayed if there is no previous data in the memory:

```
=====> TEST SAVED! <=====
```

   The following screen will be displayed if previous data for the same test type is stored in the memory:

```
PREVIOUS DATA IN BUF?
03/01/09            10:30
1. APPEND PREV DATA?
2. CLEAR PREV DATA
```

   The LTCA-10/40 retains the current test results in its working memory. When a test is finished, the user can append the new test results to the previous test results in the working memory, as long as the unit's power has not been turned off between tests.

   If data exists in the working memory, you will be presented with the "PREVIOUS DATA IN BUF?" menu shown above. Press the **[1]** key to append the current test results to the previous test results in the working memory. Press the **[2]** key to

only save the current test results and discard any previous data from the working memory.
In either case, press the **[ENTER]** key and **continue to step n**.

2. *NO*
   If you do not wish to save the reading, press the **[2]** key (*NO*) and **continue to step n**.

n. The "RUN ANOTHER TEST?" menu will be displayed:

```
RUN ANOTHER TEST?
1. YES
2. NO
```

1. *YES*
   If you would like to run another test, press the **[1]** key (*YES*) and **return to step c**.

2. *NO*
   If you do not wish to run another test, press the **[2]** key (*NO*) and **continue to step o**.

o. The "SAVE THIS RECORD?" menu will be displayed:

```
SAVE THIS RECORD?
1. YES
2. NO
```

NOTE
The test record must be saved to Flash EEPROM so that it can be recalled and printed at a later time.

1. *YES*
   If you wish to save the record, press the **[1]** key (*YES*) and **continue to step p**.

2. *NO*
   If you do not wish to save the record, press the **[2]** key (*NO*). The following message will be displayed:

```
ARE YOU SURE?
DATE WILL BE LOST!
1. DO NOT SAVE RECORD
2. SAVE RECORD
```

   Press the **[1]** key (*DO NOT SAVE RECORD*) if you do not want to save the record. You will be returned to the "START-UP" menu.

   Press the **[2]** key (*SAVE RECORD*) to save the record. **Continue to step p**.

p. The following message will be displayed:

```
RECORD NUMBER 01
 HAS BEEN SAVED!
```

NOTE

The record number is automatically assigned and incremented by the LTCA-10/40.

Press the **[ENTER]** key to return to the "START-UP" menu.

5.5.1. Resistance Test Result Printouts

```
            TEST   RESULTS
DATE:  09/19/08    TIME:  11:55:31

COMPANY:    PLN
STATION:    AP2B
CIRCUIT:    TRAFO 4 GI CPK
MFR:        PASTI
MODEL:      1234567890
SN:         12345678901234567890
KVA RTG:    10 MVA
OPERATOR:   HAI

   EQUIVALENT RESISTANCE DATA
MEAS TEMP   Tm = 25.0C  77.0F
REF TEMP    Ts = 85.0C  185.0F
ALUMINUM WINDINGS, TK = 225.0C

Rs = Rmeas x [(Ts+Tk)/(Tm+Tk)]
All temps for eqn are in deg C

         V1, V2, V3 TEST

        TESTED AT 10 AMPS
R1  = 7.285 MILLI-OHMS
R1s = 9.033 MILLI-OHMS

R2  = 52 MICRO-OHMS
R2s = 64 MICRO-OHMS

R3  = 37 MICRO-OHMS
R3s = 46 MICRO-OHMS

TAP/WINDING: ____________________

DATE:  09/19/08    TIME:  11:55:31
```


Figure 8.0 Typical Triple Reading Test Report Printout

```
            TEST   RESULTS
DATE:  09/22/08    TIME:  13:53:49

COMPANY:
STATION:
CIRCUIT:
MFR:
MODEL:
SN:
KVA RTG:
OPERATOR:

   EQUIVALENT RESISTANCE DATA
MEAS TEMP   Tm = 25.0C  77.0F
REF TEMP    Ts = 85.0C  185.0F
COPPER WINDINGS, TK = 234.5C

Rs = Rmeas x [(Ts+Tk)/(Tm+Tk)]
All temps for eqn are in deg C

           V1 & V2 TEST

        TESTED AT 5 AMPS
R1  = 7.260 MILLI-OHMS
R1s = 8.939 MILLI-OHMS

R2  = 59 MICRO-OHMS
R2s = 73 MICRO-OHMS

TAP/WINDING: ____________________

DATE:  09/22/08    TIME:  13:53:49
```

Figure 9.0 Typical Dual Reading Test Report Printout

```
TEST RESULTS
DATE: 09/22/08    TIME: 14:13:21
COMPANY:
STATION:
CIRCUIT:
MFR:
MODEL:
SN:
KVA RTG:
OPERATOR:
  EQUIVALENT RESISTANCE DATA
MEAS TEMP   Tm = 25.0C 77.0F
REF TEMP    Ts = 85.0C 185.0F
COPPER WINDINGS, TK = 234.5C

Rs = Rmeas x [(Ts+Tk)/(Tm+Tk)]
All temps for eqn are in deg C

         V1 ONLY TEST

       TESTED AT 5 AMPS
R1  = 7.261 MILLI-OHMS
R1s = 8.940 MILLI-OHMS
TAP/WINDING: ____________________
DATE: 09/22/08    TIME: 14:13:21
```

Figure 10.0 Typical Single Reading Test Report Printout

5.6 Performing a Special Resistance Test

The Special Resistance Test is used to conduct a resistance test for a pre-defined period ranging from 1 to 45 minutes. The resistance data is recorded at 1 minute intervals. Use the following procedures to perform a Special Resistance Test.

a. Start from the "START-UP" menu:

```
1. TEST XFMR      03/04/09
2. SETUP          09:28:03
3. USER DIAG
```

Press the **[1]** key (*TEST XFMR*) to start a test.

b. The following menu will be displayed:

```
1. RESISTANCE TEST
2. SPECIAL RESISTANCE TEST
3. DYNAMIC LTC TEST
```

Press the **[2]** key (*SPECIAL RESISTANCE TEST*) to start a special resistance test.

c. The following menu will be displayed:

```
1. V1, V2, V3 SPEC TEST
2. V1, V2     SPEC TEST
3. V1 ONLY    SPEC TEST
```

Select the number of channels by pressing the corresponding key (**[1]**, **[2]**, or **[3]**)

d. The "ENTER SPECIAL TEST TIME MINUTES" screen will be displayed:

```
   ENTER SPECIAL TEST
  TIME MINUTES (1-45):
         10
```

Enter the test time (between 1-45 minutes) using the keypad on the LTCA-10/40 and then press the **[ENTER]** key. Ten (10) minutes is used for the test time in this example.

e. The "SELECT TEST CURRENT" menu will be displayed:

```
SELECT TEST CURRENT:
1. 1 AMP
2. 5 AMPS
3. 10 AMPS
```

LTCA-10

```
SELECT TEST CURRENT:
1. 1 AMP
2. 5 AMPS
3. 10 AMPS
4. 40 AMPS
```

LTCA-40

Select the test current by pressing the **[1]**, **[2]**, **[3]** , or **[4]** (LTCA-40 only) key.

f. The "CONVERT READINGS TO STANDARD TEMP?" menu will be displayed:

```
   CONVERT READINGS TO
     STANDARD TEMP?
1. YES
2. NO
```

1. *YES*
   If you wish to convert readings to standard temperature, press the **[1]** key (*YES*). The "WINDING MATERIAL" menu will be displayed:

```
    WINDING MATERIAL
1. COPPER, Tk=234.5
2. ALUMINUM, Tk=225.0
3. MANUALLY ENTER Tk
```

   a. Press the **[1]** key to select copper as the winding material. **Continue to step g.**

   b. Press the **[2]** key to select aluminum as the winding material. **Continue to step g.**

   c. Press the **[3]** key to manually enter the Tk value. The following screen will be displayed:

```
         Tk:
       230.0°C

↑↓ to adjust Tk
"ENTER" to accept
```


   You can increase the Tk value by 0.5°C increments by pressing the **[PAPER ∧ Contrast]** key.

   You can decrease the Tk value by 0.5°C increments by pressing the **[PAPER ∨ Contrast]** key.

   Press the **[ENTER]** key to confirm your temperature selection. **Continue to step g.**

2. *NO*
   If you do NOT wish to convert readings to standard temperature, press the **[2]** key (*NO*) and **continue to step i**.

g. After the Tk value has been selected, the "D.U.T. TEMP" screen will be displayed:

```
      D.U.T. TEMP
    25.0°C    77.0°F

↑↓ to adjust temp
"ENTER" to accept
```

Use the **[PAPER ∧ Contrast]** and **[PAPER ∨ Contrast]** keys to adjust the D.U.T. temperature.

Press the **[ENTER]** key to confirm the temperature selection.

h. The "REFERENCE TEMP" screen will be displayed:

```
      REFERENCE TEMP:
      85.0°C   185.0°F

↑↓ to adjust temp
"ENTER" to accept
```

Use the **[PAPER ∧ Contrast]** and **[PAPER ∨ Contrast]** keys to adjust the Reference Temperature. Press the **[ENTER]** key to confirm the temperature selection.

NOTE

The LTCA-10/40 will calculate the equivalent resistance value at this new temperature.

i. The following "WARNING" screen will be displayed.


```
*********WARNING*********
   DANGEROUS FLASH-OVER
   WILL OCCUR IF CABLES
    ARE DISCONNECTED!
*************************
```

This warning reminds the operator that the next sequence of test steps will run current through the test load. Press the **[ENTER]** key to proceed to the next step.

j. One of the following menus will be displayed (with the relevant test current value) depending on how many channels were selected in step c.

```
      -V1 TEST ONLY-
        1 AMP TEST

    "START" TO RUN TEST
            OR
      "STOP" TO ABORT
```

V1 Test Only

```
      -V1 & V2 TEST-
        1 AMP TEST

    "START" TO RUN TEST
            OR
      "STOP" TO ABORT
```

V1 & V2 Test

```
    -V1, V2, & V3 TEST-
        1 AMP TEST

    "START" TO RUN TEST
            OR
      "STOP" TO ABORT
```

V1, V2, & V3 Test

If you have made any errors or would like to abort the test, press the **[STOP]** key, and you will be returned to the "START-UP" menu.

Press the **[START]** key to run the test. The following screen will be displayed momentarily:

```
CALIBRATING
PLEASE WAIT…
```

After the LTCA-10/40 finishes its internal calibration, the "XFMR CHARGING" screen will be displayed:

```
XFMR CHARGING
PLEASE WAIT...

* XFMR ENERGIZED! *
```

This is only an informational screen to remind the operator that a test is in progress. The display duration of this message depends on the size of the winding's inductance and the test current selected.

NOTE You can bypass this delay and observe the resistance value immediately. See section 6.1 for instructions on how to select this option.

k. The LTCA-10/40 determines when the resistance reading is stable and shows the resistance value on the LCD as follows (the first line shows the remaining test time):

```
REMAINING TIME=10:00
  I  = 1.09 AMPS
  R1 = 7.272 mΩ

  * XFMR ENERGIZED! *
```

When the pre-defined test time has elapsed, the "TEST RESULTS" screen will be displayed:

```
TEST RESULTS
  I  = 1.09 AMPS
  R1 = 7.285 mΩ
```

NOTE The number of resistance values shown will depend on the number of channels chosen in step c.

Press the **[ENTER]** key.

l. The "SAVE THIS RECORD?" menu will be displayed:

```
SAVE THIS RECORD?
1. YES
2. NO
```

NOTE

The test record must be saved to Flash EEPROM so that it can be recalled and printed at a later time.

1. *YES*
   If you wish to save the record, press the **[1]** key (*YES*) and **continue to step m**.

2. *NO*
   If you do not wish to save the record, press the **[2]** key (*NO*). The following message will be displayed:

   ```
   ARE YOU SURE?
   DATE WILL BE LOST!
   1. DO NOT SAVE RECORD
   2. SAVE RECORD
   ```

   Press the **[1]** key (*DO NOT SAVE RECORD*) if you do not want to save the record. You will be returned to the "START-UP" menu.

   Press the **[2]** key (*SAVE RECORD*) to save the record. **Continue to step m**.

m. The following message will be displayed:

```
RECORD NUMBER 01
 HAS BEEN SAVED!
```

NOTE

The record number is automatically assigned and incremented by the LTCA-10/40.

Press the **[ENTER]** key to return to the "START-UP" menu.

5.6.1. Special Resistance Test Result Printout

```
RECORD NUMBER 57

TEST RESULTS

DATE: 09/19/08   TIME: 13:00:02

COMPANY:    PLN
STATION:    AP2B
CIRCUIT:    TRAFO 4 GI CPK
MFR:        PASTI
MODEL:      1234567890
SN:         12345678901234567890
KVA RTG:    10 MVA
OPERATOR:   HAI

EQUIVALENT RESISTANCE DATA
MEAS TEMP   Tm = 25.0C 77.0F
REF TEMP    Ts = 85.0C 185.0F
COPPER WINDINGS, TK = 234.5C

Rs = Rmeas x [(Ts+TK)/(Tm+TK)]
All temps for eqn are in deg C

V1 ONLY SPECIAL TEST   T=0 MIN

      TESTED AT 1 AMP
   R1  = 7.282 MILLI-OHMS
   R1s = 8.966 MILLI-OHMS

V1 ONLY SPECIAL TEST   T=1 MIN

      TESTED AT 1 AMP
   R1  = 7.283 MILLI-OHMS
   R1s = 8.967 MILLI-OHMS

V1 ONLY SPECIAL TEST   T=2 MIN

      TESTED AT 1 AMP
   R1  = 7.282 MILLI-OHMS
   R1s = 8.965 MILLI-OHMS

V1 ONLY SPECIAL TEST   T=3 MIN

      TESTED AT 1 AMP
   R1  = 7.283 MILLI-OHMS
   R1s = 8.967 MILLI-OHMS

V1 ONLY SPECIAL TEST   T=4 MIN

      TESTED AT 1 AMP
   R1  = 7.281 MILLI-OHMS
   R1s = 8.964 MILLI-OHMS

V1 ONLY SPECIAL TEST   T=5 MIN

      TESTED AT 1 AMP
   R1  = 7.282 MILLI-OHMS
   R1s = 8.966 MILLI-OHMS
```


Figure 11.0 Typical Single Reading Test Report Printout

5.7 Performing a Dynamic LTC Test

The Dynamic LTC Test is used to conduct a resistance test while the LTC or Regulator is switching taps. The test time can be selected for a period from 15 to 240 seconds to allow the LTC or Regulator enough time to switch through all of its taps during the test. The resistance data is recorded continuously during the test period. The AC current probe can be clamped around one of the motor leads to monitor the motor current during the test. Use the following steps to perform a Dynamic LTC Test.

a. Start from the "START-UP" menu:

```
1. TEST XFMR       03/04/09
2. SETUP           09:28:03
3. USER DIAG
```

Press the **[1]** key (*TEST XFMR*) to start a test.

b. The following menu will be displayed:

```
1. RESISTANCE TEST
2. SPECIAL RESISTANCE TEST
3. DYNAMIC LTC TEST
```

Press the **[3]** key (*DYNAMIC LTC TEST*) to start a dynamic LTC test.

c. The following menu will be displayed:

```
SELECT SHOT TIME
1. 15  SECONDS
2. 30  SECONDS
3. 60  SECONDS
4. 120 SECONDS
5. 240 SECONDS
```

Select the shot time by pressing the corresponding key on the LTCA-10/40's keypad (**[1]**, **[2]**, **[3]**, **[4]**, or **[5]**)

d. The "SELECT TEST CURRENT" menu will be displayed as shown below. The LTCA-10 offers a selection of 5 or 10 Amps while the LTCA-10 offers a selection of 10 or 40 AMPS.

```
SELECT TEST CURRENT:
1. 5 AMPS
2. 10 AMPS
```

LTCA-10

```
SELECT TEST CURRENT:
1. 10 AMPS
2. 40 AMPS
```

LTCA-40

Select the test current by pressing the corresponding key on the LTCA-10/40's keypad (**[1]** or **[2]**).

e. The following "WARNING" screen will be displayed:

```
*********WARNING*********
  DANGEROUS FLASH-OVER
  WILL OCCUR IF CABLES
   ARE DISCONNECTED!
*************************
```

This warning reminds the operator that the next sequence of test steps will run current through the test load.

Press the **[ENTER]** key to proceed to the next step.

f. The "LTC TEST" screen will be displayed (with the relevant test current value selected in step d):

```
        LTC TEST
      10 AMP TEST
  "START" TO RUN TEST
           OR
    "STOP" TO ABORT
```


If you have made any errors or would like to abort the test, press the **[STOP]** key, and you will be returned to the "START-UP" menu.

Press the **[START]** key to run the test. The following screen will be displayed momentarily:

```
      CALIBRATING
     PLEASE WAIT…
```

After the LTCA-10/40 finishes its internal calibration, the "XFMR CHARGING" screen will be displayed:

```
     XFMR CHARGING
     PLEASE WAIT...

  * XFMR ENERGIZED! *
```

This is only an informational screen to remind the operator that a test is in progress. The display duration of this message depends on the size of the winding's inductance and the test current selected.

g. The LTCA-10/40 determines when the resistance reading is stable and displays the "READY TO CAPTURE DATA" screen:

```
 READY TO CAPTURE DATA
     PRESS "ENTER"
           OR
    LTC RAISE/LOWER
    TO START TIMING
  * XFMR ENERGIZED! *
```

Press the **[ENTER]** key to start capturing data for the time period selected in **step e**. The LTC must be manually started to begin switching through the taps.

If the LTC cable is connected, then pressing the **[LTC RAISE]** key when cycling from lower to higher taps or pressing the **[LTC LOWER]** key when cycling from higher to lower taps will start capturing data.

The following screen will be displayed indicating that the test is in progress:

```
RUNNING DYNAMIC
LTC TEST        T = 15
R1 = 7.369 mΩ
"STOP" KEY TO ABORT
    * XFMR ENERGIZED! *
```

h. When the pre-defined test time has elapsed or the **[STOP]** key is pressed, the "PRINT TEST RESULTS?" menu will be displayed:

```
PRINT TEST RESULTS?
1. YES
2. NO
```


1. *YES*
   Press the **[1]** key (*YES*) to print the test results on the built-in thermal printer. The following menu will be displayed:

   ```
   SELECT PLOT TYPE:
   1. NORMAL PLOT
   2. EXPANDED PLOT
   ```

   1. *NORMAL PLOT*
      Press the **[1]** key (*NORMAL PLOT*) to print a normal plot. The printer will begin to print. A typical normal (full-scale) plot is shown in figure 11.0. **Continue to step i.**
   2. *EXPANDED PLOT*
      To print an expanded plot, press the **[2]** key (*EXPANDED PLOT*). **Continue to step i.**

2. *NO*
   Press the **[2]** key (*NO*) to bypass the printing of the test results. **Continue to step j.**

i. The "PRINT AN EXPANSION PLOT" menu will be displayed:

```
PRINT AN EXPANSION
PLOT?
1. YES
2. NO
```

1. *YES*
   An expansion plot graphs the resistance waveform in more detail by allowing the selection of a timeframe to be plotted using an appropriate resistance scale. Press the **[1]** key (*YES*) to print an expansion plot. The following menu will be displayed:

   ```
   1. EXPANDED TIME & RES
   2. EXPANDED RES ONLY
   ```

   Press the corresponding key (**[1]** or **[2]**) to select the expansion type. The "EXPANSION PRINT" menu will be displayed:

   ```
   EXPANSION PRINT
   START TIME: 0 S
   END TIME:   0 S
   ```

   Enter the START time and press the **[ENTER]** key. Enter the END time and press the **[ENTER]** key. The "RESISTANCE PLOT RANGE" menu will be displayed:


   ```
   RESISTANCE PLOT RANGE
   1. FULL RANGE
   2. 100µΩ - 10mΩ
   3. 1mΩ - 100mΩ
   4. 10mΩ - 1Ω
   5. 100mΩ - 10Ω
   6. 1Ω - 100Ω
   ```

   Select the resistance plot range by pressing the corresponding key on the LTCA-10/40's keypad (**[1]**, **[2]**, **[3]**, **[4]**, **[5]**, or **[6]**). The printer will begin the print the expansion plot. A time expansion plot from 17.0 seconds to 18.00 seconds and resistance scale from 100 milli-ohms to 10 ohms is shown in figure 12.0.

   When printing is completed, you will be returned to the "PRINT AN EXPANSION PLOT?" menu and offered the option to print another expansion. **Return to step i.**

2. *NO*
   Press the **[2]** key (*NO*) if you do not wish to print an expansion. **Continue to step j.**

j. The "SAVE THIS RECORD?" menu will be displayed:

```
SAVE THIS RECORD?
1. YES
2. NO
```

NOTE

The test record must be saved to Flash EEPROM so that it can be recalled and printed at a later time.

1. *YES*
   If you wish to save the record, press the **[1]** key (*YES*) and **continue to step k**.

2. *NO*
   If you do not wish to save the record, press the **[2]** key (*NO*). The following message will be displayed:

   ```
   ARE YOU SURE?
   DATE WILL BE LOST!
   1. DO NOT SAVE RECORD
   2. SAVE RECORD
   ```

   Press the **[1]** key (*DO NOT SAVE RECORD*) if you do not want to save the record. You will be returned to the "START-UP" menu.

   Press the **[2]** key (*SAVE RECORD*) to save the record. **Continue to step k**.

k. The following message will be displayed:

```
RECORD NUMBER 01
 HAS BEEN SAVED!
```

NOTE

The record number is automatically assigned and incremented by the LTCA-10/40.

Press the **[ENTER]** key to return to the "START-UP" menu.

5.7.1. Dynamic LTC Test Result Printouts

RECORD NUMBER 47

TEST RESULTS

DATE: 08/19/08 TIME: 00:14:35

COMPANY: PLN
STATION: AP2B
CIRCUIT: TRAFO 4 GI CPK
MFR: PASTI
MODEL: 1234567890
SN: 12345678901234567890
KVA RTG: 10 MVA
OPERATOR: HAI

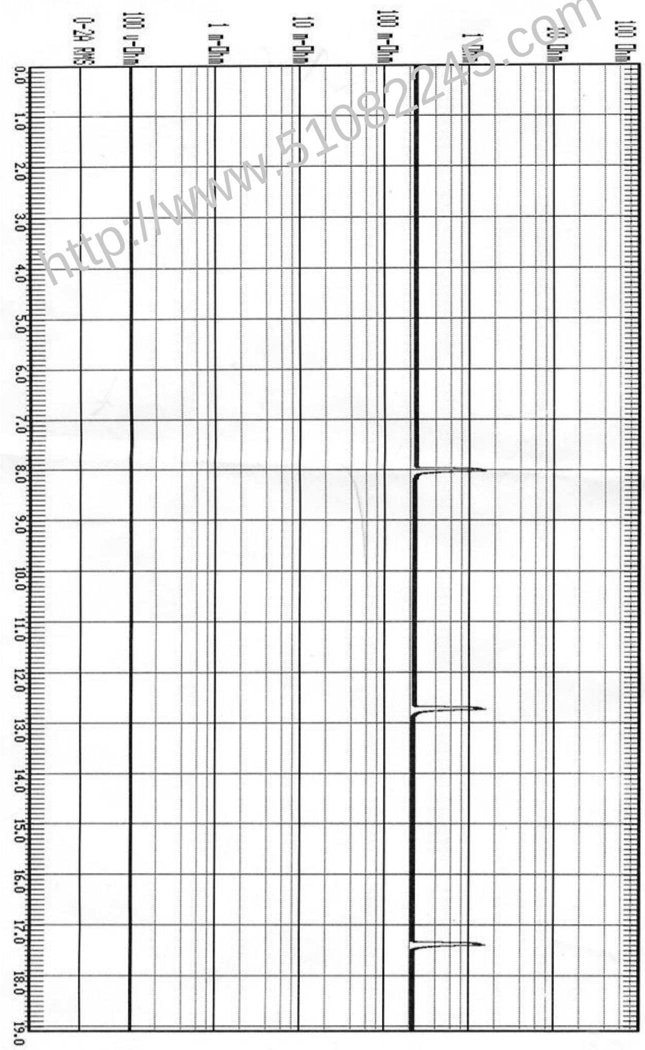
V1 LTC TEST

TESTED AT 40 AMPS

2000 Hz SAMPLE RATE

RESISTANCE PLOT

MARKERS AT 100 mS INTERVALS



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LTCA-10 REV 0.94 (C) 2008
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WWW.VANGUARD-INSTRUMENTS.COM
SERIAL NUMBER: 43001

Figure 12.0 Sample Normal Dynamic LTC Test Plot

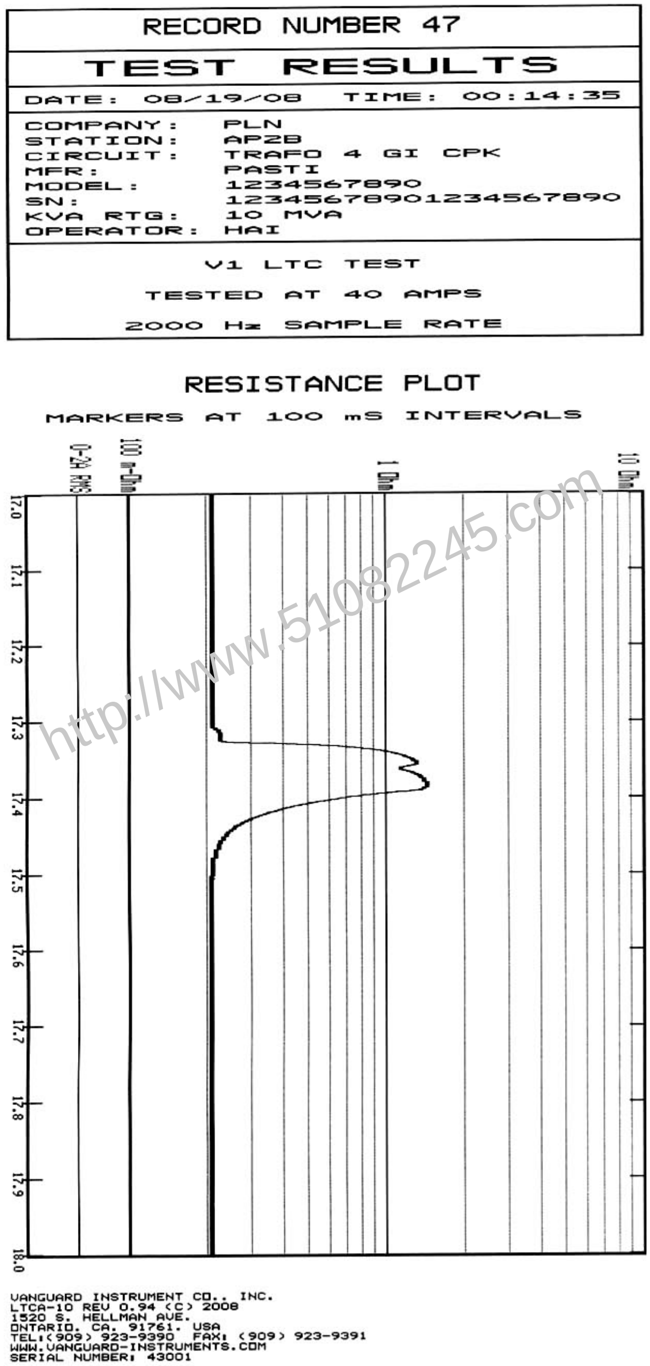


Figure 13.0 Sample Dynamic LTC Test Expansion Plot

5.8 Diagnostic Mode

In diagnostic mode, the LTCA-10/40 can run a resistance test, display the sense voltages, and test current on the LTCA. This feature can be used to verify the LTCA-10/40's voltage and current readings against an external meter. Use the steps below to initiate a diagnostic test.

a. Start from the "START-UP" menu:

```
1. TEST XFMR      03/04/09
2. SETUP          09:28:03
3. USER DIAG
```

Press the **[3]** key (*USER DIAG*).

b. The "SELECT TEST CURRENT" menu will be displayed:

```
SELECT TEST CURRENT:
1. 1 AMP
2. 5 AMPS
3. 10 AMPS
```

LTCA-10

```
SELECT TEST CURRENT:
1. 1 AMP
2. 5 AMPS
3. 10 AMPS
4. 40 AMPS
```

LTCA-40

Select the test current by pressing the **[1]**, **[2]**, **[3]** , or **[4]** (LTCA-40 only) key.

c. The following "WARNING" screen will be displayed:

```
*********WARNING*********
  DANGEROUS FLASH-OVER
  WILL OCCUR IF CABLES
   ARE DISCONNECTED!
*************************
```

This warning reminds the operator that the next sequence of test steps will run current through the test load.

Press the **[ENTER]** key to proceed to the next step.

d. The following screen will be displayed:

```
    -USER DIAG TEST-
  "START" TO RUN TEST
          OR
    "STOP" TO ABORT
```

If you wish to abort the diagnostic test, press the **[STOP]** key, and you will be returned to the "START-UP" menu.

Press the **[START]** key to run the diagnostic test.

e. The V1, V2, and V3 test currents will be displayed as shown below:

```
V1 = 07.53mV
V2 = 08.23mV
V3 = 09.12mV
I  = 01.091A
```

Press the **[STOP]** key to end the diagnostic test and return to the "START-UP" menu.

5.9 Setup Menu

The setup menu is used to configure the LTCA-10/40 and to also recall and print stored test records. This section outlines the procedures for accessing and using the Setup Menu options.

5.9.1. Entering the Transformer ID

Transformer information can be entered using the steps outlined below.

NOTE

Test identification data is entered using the LTCA-10/40's alpha-numeric keypad. Keys are pressed for each character position (marked by the cursor) in the identification area. For example, pressing the **[2]** key once selects the number "2". Pressing it a second time selects the letter "A". A third press selects the letter "B". Pressing the key a fourth time selects the letter "C". Pressing the key one more time restarts the cycle at the number "2".

The characters selected are entered at the position of the cursor. Pressing the **[PAPER ∧ Contrast]** key advances the cursor by one space while pressing the **[PAPER ∨ Contrast]** key moves the cursor back one space. If a character is erroneously entered, select the new key to get the desired entry.

a. Start from the "START-UP" menu:

```
1. TEST XFMR      03/04/09
2. SETUP          09:28:03
3. USER DIAG
```

Press the **[2]** key (*SETUP*).

b. The following menu will be displayed:

```
1. ENTER XFMR ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET FONT
```

Press the **[1]** key (*ENTER XFMR ID*).

c. The "COMPANY" screen will be displayed:

```
COMPANY:

↑/↓ TO POSITION
"ENTER TO ACCEPT"
```

Enter the utility company's name by using the LTCA-10/40's alpha-numeric keypad, and then press the **[ENTER]** key.

d. The "STATION" screen will be displayed:

```
STATION:

↑/↓ TO POSITION
"ENTER TO ACCEPT"
```

Enter the station name by using the LTCA-10/40's alpha-numeric keypad, and then press the **[ENTER]** key.

e. The "CIRCUIT" screen will be displayed:

```
CIRCUIT:

↑/↓ TO POSITION
"ENTER TO ACCEPT"
```

Enter the circuit name by using the LTCA-10/40's alpha-numeric keypad, and then press the **[ENTER]** key.

f. The "MANUFACTURER" screen will be displayed:

```
MANUFACTURER:

↑/↓ TO POSITION
"ENTER TO ACCEPT"
```


Enter the transformer manufacturer name by using the LTCA-10/40's alpha-numeric keypad, and then press the **[ENTER]** key.

g. The "MODEL" screen will be displayed:

```
MODEL:

↑/↓ TO POSITION
"ENTER TO ACCEPT"
```

Enter the transformer model name/number by using the LTCA-10/40's alpha-numeric keypad, and then press the **[ENTER]** key.

h. The "SERIAL NUMBER" screen will be displayed:

```
SERIAL NUMBER:

↑/↓ TO POSITION
"ENTER TO ACCEPT"
```

Enter the transformer's serial number by using the LTCA-10/40's alpha-numeric keypad, and then press the **[ENTER]** key.

i. The "KVA RATING" screen will be displayed:

```
KVA RATING:

↑/↓ TO POSITION
"ENTER TO ACCEPT"
```

Enter the transformer's KVA rating by using the LTCA-10/40's alpha-numeric keypad, and then press the **[ENTER]** key.

j. The "OPERATOR" screen will be displayed:

```
OPERATOR:

↑/↓ TO POSITION
"ENTER TO ACCEPT"
```

Enter the name of the operator by using the LTCA-10/40's alpha-numeric keypad, and then press the **[ENTER]** key. You will be returned to the "START-UP" menu.

5.9.2. Restoring a Test Record

Use the following steps to restore a test record from the LTCA-10/40's Flash EEPROM to the unit's working memory.

a. Start from the "START-UP" menu:

```
1. TEST XFMR      03/04/09
2. SETUP          09:28:03
3. USER DIAG
```

Press the **[2]** key (*SETUP*).

b. The following menu will be displayed:

```
1. ENTER XFMR ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET FONT
```

Press the **[3]** key (*SAVE/RESTORE RECORD*)

c. The following menu will be displayed:

```
1. RESTORE RECORD
2. SAVE RECORD
3. RECORD DIRECTORY
4. ERASE RECORD
```

Press the **[1]** key (*RESTORE RECORD*)

d. The "RESTORE RECORD" menu will be displayed:

```
      RESTORE RECORD
1. ENTER RECORD NUMBER
2. SCROLL TO SELECT
```

1. *ENTER RECORD NUMBER*
   Press the **[1]** key if you know the record number. The following screen will be displayed:

   ```
   RESTORE RECORD
   NUMBER:
   ```

   Enter the record number using the LTCA-10/40's keypad, and then press the **[ENTER]** key. "The RESTORING RECORD" screen will be displayed momentarily:

   ```
   RESTORING RECORD
   ```

   Continue to step e.

2. *SCROLL TO SELECT*
   Press the **[2]** key if you want to scroll through the LTCA-10/40's record directory to find the record number. The "RECORDS DIRECTORY" screen will be displayed:

```
RECORDS DIRECTORY

"UP" TO SCROLL FWD
"DWN" TO SCROLL RVS
```

   Press the **[PAPER ∧ Contrast]** key to show the first record header in memory. The first record header will be displayed:

```
#9   03/12/09   15:22
NUM OF TESTS: 3
```

   Continue to press the **[PAPER ∧ Contrast]** and **[PAPER ∨ Contrast]** keys to find the desired record. Press the **[ENTER]** key to load restore the desired record. The "RESTORING RECORD" screen will be displayed momentarily:

```
RESTORING RECORD
```

   Continue to step e.

e. Once a record has been restored, the following screen will be displayed:

```
RECORD RESTORED:
PRINT RECORD?
1. YES
2. NO
```

1. *YES*
   Press the **[1]** key (*YES*) to print the restored record. The printer will print the selected record, and the display will return to the "START-UP" menu once printing is completed. See figure 13.0 for a typical test record printout.

2. *NO*
   Press the **[2]** key (*NO*) if you do not wish to print the restored record. The display will return to the "START-UP" menu.

RECORD NUMBER 12

TEST RESULTS

DATE: 07/01/08 TIME: 16:20:06

COMPANY: VANGUARD INSTRUMENTS
STATION: FACTORY
CIRCUIT: 1234567890
MFR: GE
MODEL: 1234567890
SN: 12345678901234567890
KVA RTG: 40 KVA
OPERATOR: HAI

V1 ONLY TEST

TESTED AT 10 AMPS

R1 = 10.610 MILLI-OHMS

TAP/WINDING: ____________________

V1 ONLY TEST

TESTED AT 10 AMPS

R1 = 10.612 MILLI-OHMS

TAP/WINDING: ____________________

V1 ONLY TEST

TESTED AT 10 AMPS

R1 = 10.613 MILLI-OHMS

TAP/WINDING: ____________________

Figure 14.0 Typical Test Record Printout

5.9.3. Printing the Test-Record Directory

A directory of all the test records stored in the LTCA-10/40's Flash EEPROM can be printed on the thermal printer using the steps below.

a. Start from the "START-UP" menu:

```
1. TEST XFMR      03/04/09
2. SETUP          09:28:03
3. USER DIAG
```

Press the **[2]** key (*SETUP*).

b. The following menu will be displayed:

```
1. ENTER XFMR ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET FONT
```

Press the **[3]** key (*SAVE/RESTORE RECORD*)

c. The following menu will be displayed:

```
1. RESTORE RECORD
2. SAVE RECORD
3. RECORD DIRECTORY
4. ERASE RECORD
```

Press the **[3]** key (*RECORD DIRECTORY*)

d. The following menu will be displayed:

```
PRINTINT DIRECTORY
1. FULL DIRECTORY
2. SHORT DIRECTORY
```

1. *FULL DIRECTORY*
   Press the **[1]** key (*FULL DIRECTORY*) to print the entire directory of test records. After the directory is printed, the display will return to the "START-UP" menu. A typical directory printout is shown in figure 14.0.

2. *SHORT DIRECTORY*
   Press the **[2]** key (*SHORT DIRECTORY*) to print a short directory listing. This lists the last 12 records store in the LTCA-10/40's memory. After the directory is printed, the display will return to the "START-UP" menu. A typical directory printout is shown in figure 14.0.

```
TEST  DIRECTORY

RECORD NUMBER: 57
DATE/TIME: 09/19/08   13:00:02
V1 ONLY SPECIAL TEST   T=5 MIN
NUMBER OF TESTS: 6
STATION:    AP2B
CIRCUIT:    TRAFO 4 GI CPK
MFR:        PASTI
MODEL:      1234567890
S/N:        12345678901234567890

RECORD NUMBER: 56
DATE/TIME: 09/19/08   12:51:39
V1 ONLY SPECIAL TEST   T=1 MIN
NUMBER OF TESTS: 2
STATION:    AP2B
CIRCUIT:    TRAFO 4 GI CPK
MFR:        PASTI
MODEL:      1234567890
S/N:        12345678901234567890

RECORD NUMBER: 55
DATE/TIME: 09/19/08   12:47:52
V1, V2, V3 SPEC TEST   T=5 MIN
NUMBER OF TESTS: 6
STATION:    AP2B
CIRCUIT:    TRAFO 4 GI CPK
MFR:        PASTI
MODEL:      1234567890
S/N:        12345678901234567890

RECORD NUMBER: 54
DATE/TIME: 09/19/08   11:55:31
V1, V2, V3 TEST
NUMBER OF TESTS: 1
STATION:    AP2B
CIRCUIT:    TRAFO 4 GI CPK
MFR:        PASTI
MODEL:      1234567890
S/N:        12345678901234567890

RECORD NUMBER: 53
DATE/TIME: 09/19/08   11:55:31
V1, V2, V3 TEST
NUMBER OF TESTS: 2
STATION:    AP2B
CIRCUIT:    TRAFO 4 GI CPK
MFR:        PASTI
MODEL:      1234567890
S/N:        12345678901234567890

RECORD NUMBER: 52
DATE/TIME: 09/19/08   11:48:43
V1 & V2 TEST
NUMBER OF TESTS: 2
STATION:    AP2B
CIRCUIT:    TRAFO 4 GI CPK
MFR:        PASTI
MODEL:      1234567890
S/N:        12345678901234567890

RECORD NUMBER: 51
DATE/TIME: 09/19/08   11:37:27
V1 & V2 TEST
NUMBER OF TESTS: 2
STATION:    AP2B
CIRCUIT:    TRAFO 4 GI CPK
MFR:        PASTI
MODEL:      1234567890
S/N:        12345678901234567890
```


Figure 15.0 Typical Record Directory Printout

5.9.4. Erasing a Test Record

Follow the steps below to erase a single test record or the entire directory of test records from the LTCA-10/40's Flash EEPROM.

a. Start from the "START-UP" menu:

```
1. TEST XFMR      03/04/09
2. SETUP          09:28:03
3. USER DIAG
```

Press the **[2]** key (*SETUP*).

b. The following menu will be displayed:

```
1. ENTER XFMR ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET FONT
```

Press the **[3]** key (*SAVE/RESTORE RECORD*)

c. The following menu will be displayed:

```
1. RESTORE RECORD
2. SAVE RECORD
3. RECORD DIRECTORY
4. ERASE RECORD
```

Press the **[4]** key (*ERASE RECORD*)

d. The "ERASE RECORD" menu will be displayed:

```
ERASE RECORD

1. ERASE SINGLE RECORD
2. ERASE ALL RECORDS

"STOP" TO EXIT
```

Press the **[STOP]** key if you would like to end the process and return to the "START-UP" menu. Otherwise, select one of the menu options described below:

1. *ERASE SINGLE RECORD*
   Press the **[1]** key (*ERASE SINGLE RECORD*) to erase a single record. You will be presented with the following screen:

```
ERASE RECORD
NUMBER: XX
```

Enter the number of the record to erase and then press the **[ENTER]** key. The following screen will be displayed to confirm that the record was deleted:

```
RECORD NUMBER XX
ERASED!
```

Press the **[ENTER]** key and you will be returned to the beginning of step d.

2. *ERASE ALL RECORDS*
   Press the **[2]** key (*ERASE ALL RECORDS*) to erase all records stored in the LTCA-10/40's memory. The following confirmation screen will be displayed:

```
ERASE ALL RECORDS!
ARE YOU SURE?
"ENTER" TO CONTINUE
```


Press the **[STOP]** key to cancel the process and return to the "START-UP" menu.

Press the **[ENTER]** key to erase all test records. The following screen will be displayed showing a progress bar:

```
ERASING RECORDS
PLEASE WAIT...
```

Once all records have been erased, the following screen will be displayed:

```
RECORDS ERASED!
```

Press the **[ENTER]** key to return to the "START-UP" menu.

5.9.5. Enabling the Computer Interface

The Computer Interface Mode is used to transfer test records from the LTCA-10/40's Flash EEPROM to a PC via the RS-232C or USB port. To use this mode, first run the provided PC software and then connect the PC to the RS-232C or USB port on the LTCA-10/40. The software will automatically make the connection to the LTCA-10/40.

5.9.6. Setting the Date and Time

a. Start from the "START-UP" menu:

```
1. TEST XFMR      03/04/09
2. SETUP          09:28:03
3. USER DIAG
```

Press the **[2]** key (*SETUP*).

b. The following menu will be displayed:

```
1. ENTER XFMR ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET FONT
```

Press the **[4]** key (*SET TIME*)

c. The following screen will be displayed:

```
          ENTER
MM-DD-YY    HH:MM:SS
_
```

Type in the Date and Time using the alpha-numeric keypad. When the complete date and time has been typed in, the display will immediately return to the "START-UP" menu.

5.9.7. Setting the Test Value Display Font

The font used to display test values on the screen can be made bold for better visibility. This only affects the test values displayed during testing and does not affect any other text such as menu items. Use the steps below to set the test value font.

a. Start from the "START-UP" menu:

```
1. TEST XFMR      03/04/09
2. SETUP          09:28:03
3. USER DIAG
```

Press the **[2]** key (*SETUP*).

b. The following menu will be displayed:

```
1. ENTER XFMR ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET FONT
```

Press the **[5]** key (*SET FONT*).

c. The "SELECT TEST FONT" menu will be displayed:

```
     SELECT TEST FONT
1. NORMAL FONT
2. BOLD FONT
```

1. *NORMAL FONT*
   Press the **[1]** key (*NORMAL FONT*) to select the normal font. The screen will return to the "START-UP" menu.

2. *BOLD FONT*
   Press the **[2]** key (*BOLD FONT*) to select the bold font. The screen will return to the "START-UP" menu.

6.0 LTCA-10/40 SPECIAL FEATURES

6.1 Bypassing the Resistance Value Display Delay

When the LTCA-10/40 first applies the test voltage to the transformers winding, the current is increased slowly until the transformer's winding reaches saturation. During this period, the resistance value varies substantially and the readings may appear unstable to the operator. The LTCA-10/40 has a built-in 3 minute minimum delay between the start of the test and when the resistance value is displayed on the LCD. This feature eliminates the possibility of early erroneous readings. Depending on the transformer size, the delay may be longer than 3 minutes.

The operator can bypass this delay and observe the test results immediately. To bypass this delay, press the **[9]** key, the **[8]** key, and the **[7]** key from the "START-UP" menu. The LTCA-10/40 will then begin displaying resistance values as soon as measurements are made. This bypass setting will remain active until the unit is turned off. When the unit is turned on again, it will use the default 3 minute minimum delay before displaying resistance values.

6.2 Converting Resistance Measurements

The LTCA-10/40 can convert the resistance reading of the device under test at its present temperature to the equivalent resistance value at a different temperature. The conversion is accomplished by the following formula:

Rs = Rm (Ts + Tk) / (Tm + Tk)

Where:
Rs is the resistance at desired temperature
Rm is the measured resistance
Ts is the desired reference temperature
Tm is the temperature at which the resistance was measured
Tk is the constant used for the winding material
  Tk = 234.5 for copper
  Tk = 240.0 for aluminum

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